The combined effect of a homogenous diet, increased atmospheric carbon dioxide, and pesticides on the functioning of a wild bee

There are approximately 500 wild bee species in Poland. Wild bees are irreplaceable yet unacknowledged actors, as all media attention is focused on domesticated industrially farmed honey bees. However, not only honey bees but also wild bees pollinate field crops, providing us with the food we love. Alarmingly, in recent years, substantial declines have been observed in the abundance and biodiversity of bees. There are many drivers of bee decline, but in general, human activity is most significantly detrimental to bees. Major threats to bees include habitat loss and transformation, plant protection products (pesticides), and climate change. These stressors cause bee food to deteriorate and consequently reduce bee health and prosperity.

Habitat transformation may lead to the formation of monocultures (single-crop plantations). Large monocultures provide bees with only one type of pollen and nectar, thus leading to a homogenous and nutritionally imbalanced diet. Moreover, considering that bees are pollinators of crops, fruits and vegetables, there is a high risk that they are subjected to pesticides. Among pesticides, insecticides are designed to be toxic to insect pests. However, insecticides are not selective and are toxic to other (nontarget) insects, including bees. At the global scale, in turn, the emission of carbon dioxide (CO_2) can cause an increase in the carbohydrate content in plants at the expense of other macro- and micronutrients, e.g., proteins. In brief, the higher the atmospheric CO_2 concentration is, the more plants grow, and this growth is associated with an increase in the carbon content in plant tissues and a proportional decrease in other elements, e.g., N, Zn or Fe. Importantly, the greatest shift is expected for the C:N ratio, which may cause nutritional imbalances in pollen consumed by bees.

For every organism, the juvenile period, when organisms grow and develop, is crucial for the wellbeing of the organism at later life stages. Bees are no exception. Wild bee mothers collect pollen to feed their growing younglings. Conditions may become increasingly unfavorable as humans change once diverse and rich landscapes into grasslands and crop monocultures contaminated with pesticides. In addition, elevated CO_2 levels reduce the quality of available bee food. We still know very little about the mechanism driving the combined effect of all these negative factors on wild bees. To help bees and to still be able to eat our own beloved food, we need to learn more.

The goal of this project is to learn how the combined effects of a homogenous diet, pesticides and climate change affect the health and well-being of a wild bee species. To this end, we will perform an array of complementary feeding experiments under controlled laboratory conditions, breeding the solitary red mason bee (*Osmia bicornis*) on various pollen provisions. These provisions will simulate different scenarios of bees inhabiting landscapes varying in the degrees of diversity/monotony and contamination/pristineness, additionally considering present and predicted atmospheric CO_2 levels.

New data gathered in this project will help improve bee conservation efforts, supporting evidence-based plans for sustainable agriculture and the global conservation of bees. Moreover, novel data will be collected encompassing the effects of climate change on pollinators, enabling future projections of global change effects on bees.